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AMERICA JOINS A METRIC WORLD

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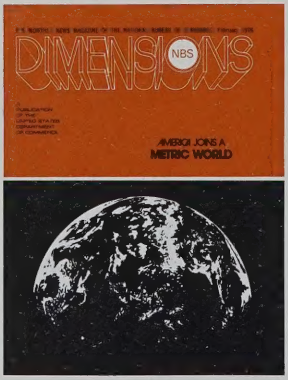

COVER: It is now official U.S. policy to foster the use of the metric system. For the story on how we will be joining a metric world, see page 6.

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The Institute for Computer Sciences and Technology
Center for Radiation Research
Center for Building Technology
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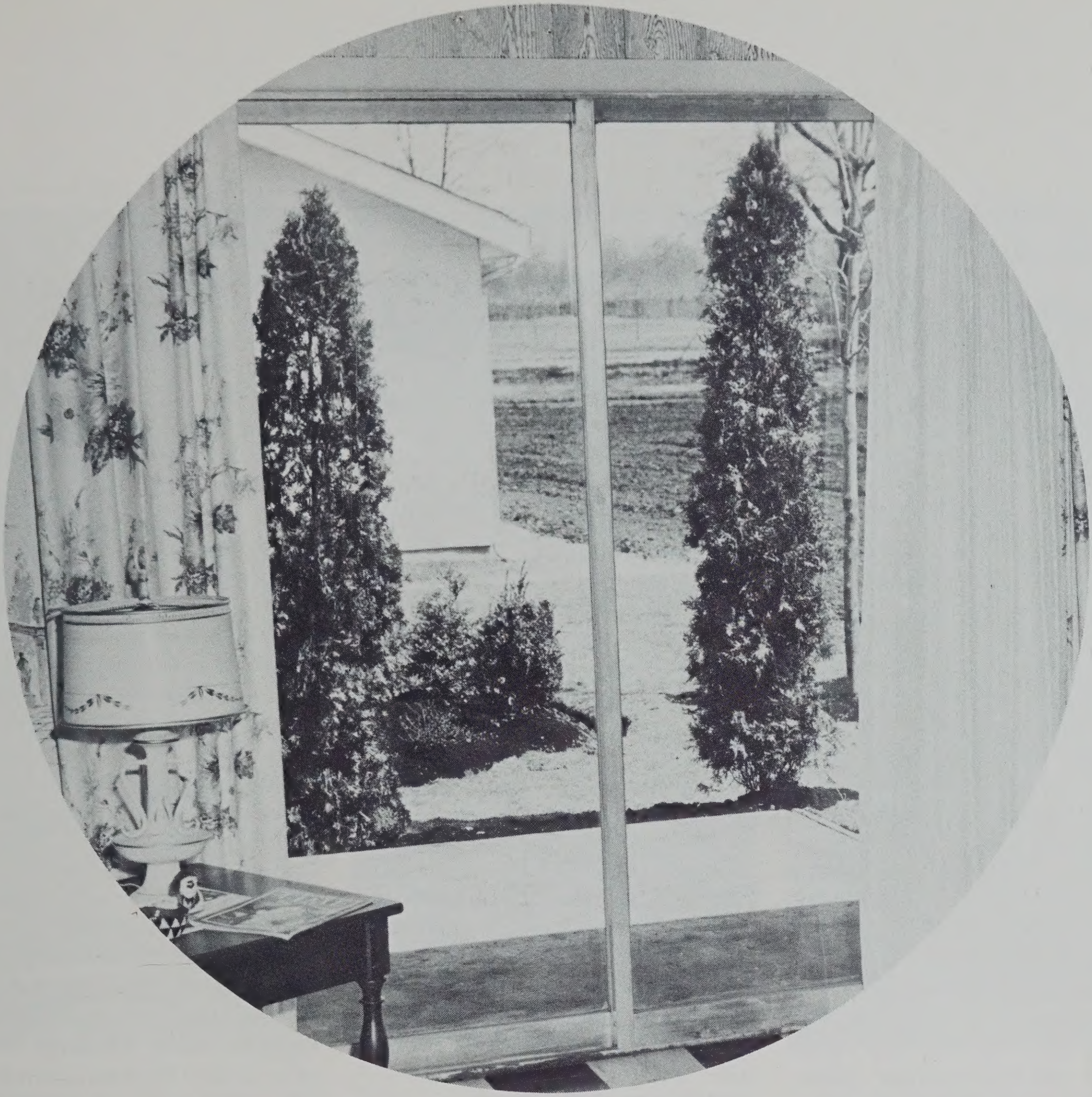

THE UNSEEN MENACE A GLASS DOOR

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"Timothy, aged 3 years 4 months, was playing with a basket of toys on the patio when he came running into the Florida room from the patio for soda. He ran full force into the plate-glass patio sliding doors between the Florida room and the living room, lost his balance, fell on the chunks of glass, cut the main artery to his heart, and bled to death within about 15 seconds."

THE above quotation, taken from the documented records of the 1969 hearings of the National Commission on Product Safety, is an example of the nearly 250,000 Americans killed or injured each year in architectural glazing accidents (Consumer Product Safety Commission estimate).

Extensive use of architectural glazing was begun in the late 1940's when expensively-priced homes in California and Florida were built with sliding glass doors. The style won instant favor and was used in more moderately-priced homes across the country. By 1965 over 2 million sliding glass panels were sold.

Gradually, as accident reports began to come in, it became apparent that sliding glass doors presented a serious hazard. Doors made of ordinary glass when broken, often produced jagged fragments that penetrated the victims.

In colder climates, similar accidents were occurring with storm doors. In 1961, the city of Seattle passed an ordinance requiring safety glass in residential structures. Two years later Washington passed the first State law requiring safety glazing in new residences.

At the request of the glazing industry, the American National Standards Institute (ANSI) formed Committee Z97 to develop a voluntary standard to test glazing materials. This standard was first issued in 1966 for voluntary use by the glazing industry.

Ordinary (annealed) glass does not pass the standard's test procedures. Properly manufactured safety glazing materials which do pass the test procedures include plastics, plastic coated annealed glass, tempered glass which is thermally or chemically treated to increase its strength, wire glass which has a layer of wire mesh imbedded within the sheet, and laminated glass which is a composite of two or more pieces of annealed glass held together by a middle layer of plastic material.

In 1969, the Consumer Safety Glazing Committee was created by the glazing industry to encourage mandatory safety glazing legislation at the State level. Their model bill, which references ANSI standard Z97.1, has been introduced in 46 State legislatures and has been adopted—with modifications—by 35 States. State glazing laws now affect over 75 percent of the U.S. population.

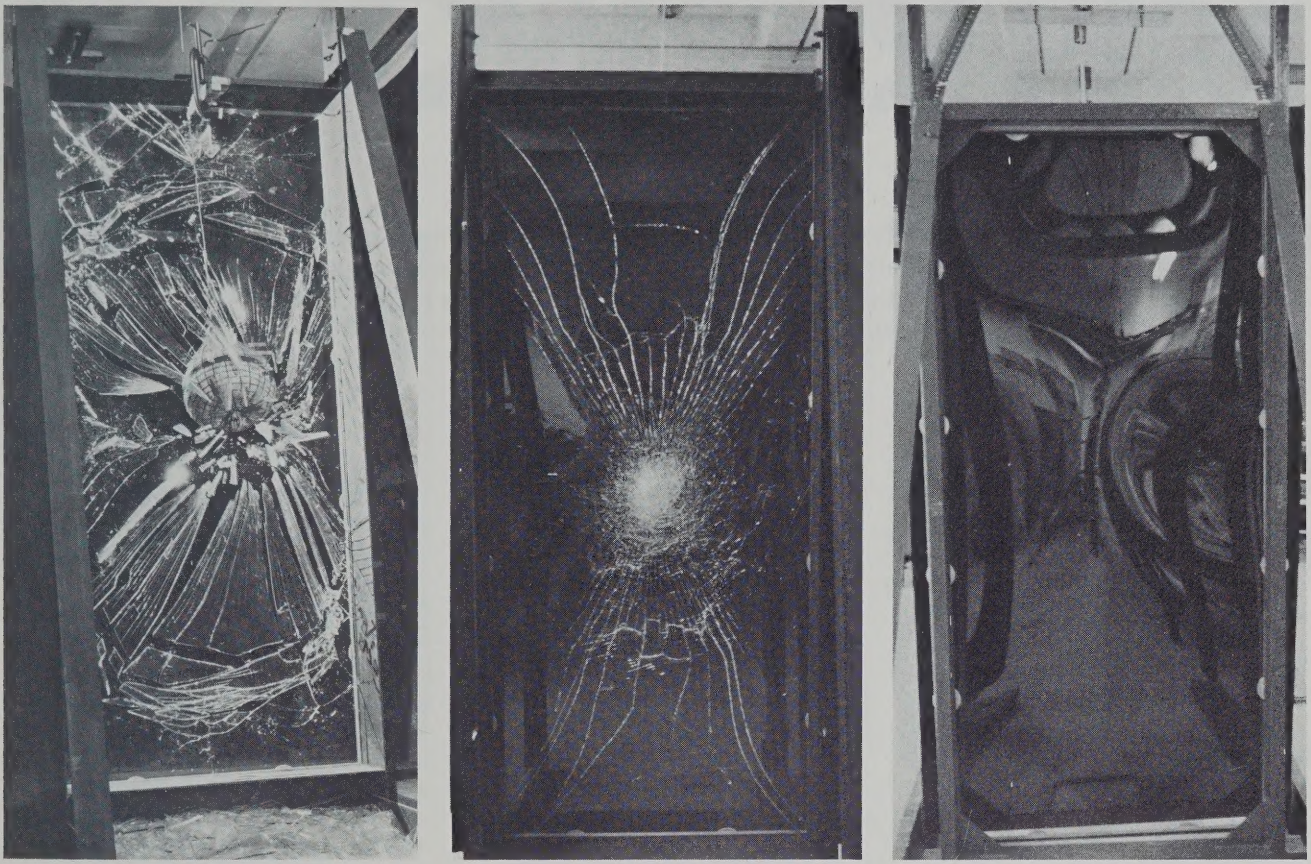
In 1973 the Consumer Safety Glazing Committee was one of the first organizations to petition the newly-formed Consumer Product Safety Commission (CPSC). It asked the CPSC to issue a consumer product safety rule relating to architectural glass. The CPSC recognizes the serious hazards associated with architectural glazing products. The CPSC FY75 hazard index ranks architectural glazing products including glass doors 16th among 100 categories of consumer products according to their number and severity of product related injuries reported.

The CPSC granted the petition of the Consumer Safety Glazing Committee and published in the Federal Register on May 28, 1974, a notice stating that the Commission had preliminarily determined that hazards associated with architectural glass present unreasonable risk of death and injury and that one or more consumer product safety standards are necessary to eliminate or reduce these unreasonable risks. The notice solicited offers to develop a standard as well as the submission of existing standards. The notice also identified various deficiencies in ANSI Z97.1-1972. After an extensive review of the existing standards submitted in response to the notice, and the offers to develop a mandatory standard, the CPSC selected the offer of the Consumer Safety Glazing Committee to develop a new standard.

Throughout this standards development process, the CPSC has utilized the technical resources of the National Bureau of Standards. This technical support has been provided since March 1974, by the Building Safety Section of NBS' Center for Building Technology. Under the direction of Sanford Adler, a professional safety engineer, NBS has reviewed and evaluated existing standards relating to architectural glazing, developed guidelines for the evaluation of offers to develop a new standard, provided a technical review of the strong and weak points of the offers made to develop a standard, monitored the standards development process, and provided a technical evaluation of the standard proposed by the Consumer Safety Glazing Committee.

Adler has worked with various types of annealed and safety glazing, including many plastics and plastic reinforced glass. Among other things,

[Photos by Sanford Adler.]



Shards and splinters fly as 100 pounds (45 kilograms) of leather and lead shot swing against a sheet of ⅛ inch (3.17 mm.) annealed glass with a force of 150 foot-pounds (203 joules) (left). In contrast, the test weight cracks but does not break through a sheet of 7/32 inch (5.5 mm.) laminated safety glass at a force of 150 ft.-lbs. (center), and only bends a sheet of ⅛ inch plastic glazing at a force of 100 ft.-lbs. (135.6 joules) (right).

he is interested in learning how important velocity is in determining the results of impact. There are little data on such parameters available from investigations of actual accidents.

Adler used a test procedure which was based on specifications included in the standard developed by the Consumer Safety Glazing Committee for the CPSC. Glazing panels rigidly mounted in a vertical steel and wood frame were impacted by a 100 pound (45 kilogram) leather bag filled with lead shot. The impactor, which is attached to a steel cable, was dropped through a pendulum arc from successive heights of 12″ (30 cm), 18″ (45 cm), and 48″ (120 cm), until the glazing was visibly damaged or left the frame.

While a national standard will prevent the problem of accidental death and injury from architectural glazing products from growing, a bigger job will be to strengthen glass already installed in homes and offices. Adler's limited testing indicates that the safety of annealed glass may be improved by a properly applied plastic coating, sheet or film. The plastic holds the pieces of glass together and prevents a person from falling through the glass.

The NBS test program supports the view that a national safety standard, combined with an aggressive program to retrofit existing glazing, can significantly reduce architectural glazing injuries.

FPM ☐

AMERICA JOINS A METRIC WORLD

"It is therefore declared that the policy of the United States shall be to coordinate and plan the increasing use of the metric system in the United States and to establish a United States Metric Board. . ."
(Metric Conversion Act of 1975)

ON December 23, 1975, President Ford signed into law the Metric Conversion Act, establishing for the first time a national policy in support of metric measurement and ending a dilemma that had continued throughout the entire history of the Republic.

George Washington had raised the issue of a more uniform system of weights and measures in his first message to Congress on January 8, 1790. John Adams and Thomas Jefferson became strong advocates of that idea, speaking favorably of the recently-developed French metric system.

Instead, the young Nation followed the tradition inherited from the British, the "customary" system of measurement. In 1875, the United States committed itself to metric by signing an international agreement, the Treaty of the Meter. This treaty was followed more in the breach than the observance. Inches, not meters, continued to reign supreme at home, although one result was that, ever since 1893, our national measurement standards have been metric.

Now at last, with the signing of the new law, the dilemma has been resolved through a national policy of coordinating the increasing use of metric in this country on a voluntary basis. The impetus for such a policy has come from our business community, which has been gradually adopting metric over the last decade. Our schools have also begun to emphasize metric, and it is apparent that the country would have drifted through metrication in an uncoordinated way unless action had been taken at the national level.

The Metric Conversion Act of 1975 created a U.S. Metric Board, appointed by the President with the advice and consent of the Senate. The Board consists of 17 members representing the various economic sectors affected by the metric changeover. These include engineering, science, large and small business, organized labor, education, manufacturing, consumers, weights and measures officials, State and local governments, and the construction industry.

The Board's function is to devise and carry out a broad program of planning, coordination and public education consistent with other national policies and interests. This legislative action is, in part, the result of the comprehensive, 3-year study performed by the National Bureau of Standards for the Secretary of Commerce and submitted to the Congress in July 1971. This study recommended that the United States change to the metric system deliberately and carefully through a coordinated program. The purpose of the Metric Conversion Act of 1975 is to accomplish this goal. It allows the development of a rational plan for a voluntary changeover. In this way, metric will come as the various sectors of our economy are ready for it—and not before.

In fact, metric has come to many sectors of American life over the past several years at an ever accelerating but erratic pace. Industry continues to take the lead in the private sector. At least 37 major corporations have announced policies to convert their operations. The total sales of these companies exceed $130 billion, and the list contains four of the Nation's 10 largest firms. Some of the first metric-minded corporations included: Caterpillar Tractor, Chrysler, Ford Motor Company, General Motors, IBM, International Harvester, Minnesota Mining and Manufacturing, Travelers Insurance, and Xerox.

Whereas until just recently the metric changeover was found predominately among manufacturers with overseas interests, some of America's largest retailers have gotten on the bandwagon. Sears, Roebuck and Company, Montgomery Ward and Company, and J. C. Penney are notable leaders in this category.

As mentioned, another sector of American life that has seen growing use of the metric system is education. School systems in all 50 states have

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by Frederick P. McGehan
NBS public information specialist

underway some type of metric activity. These activities include: making metric workshops available to teachers, providing guidelines for training of teachers, producing educational television programs, and specifying the use of metric as the primary measurement language in new textbook purchases. In more than 30 states this "trend" is reinforced by State legislation or by State school board action. In Maryland, for example, the State School Board adopted a resolution in August 1973, calling for schools to be totally metric by 1980. The State Department of Education has a well developed plan and a timetable to meet this objective.

The Congress recognized the schools' swing to metric in the Education Amendments of 1974, P.L. 93-380, which authorized a Metric Education Program to be managed by the U.S. Office of Education. Appropriated funds support model and demonstration projects aimed at improving the quality and extent of metric education. The Metric Conversion Act of 1975 also recognizes the need to train teachers and introduce metric into the Nation's classrooms. A representative of the educational community is included on the U.S. Metric Board.

The States are not limiting themselves just to metric education in schools. At the time of the signing of the bill a total of 13 states had erected some metric road signs; Georgia, Maine, and California had established State metric conversion commissions; California's Division of Oil and Gas had switched to using only metric units; Pennsylvania and Florida had cooperated with the Sun Oil Company in a pilot test to sell gasoline by the liter; North Dakota had adopted metric signs for its State parks; and bills to coordinate metric conversion had been introduced into 18 State legislatures.

State and local weights and measures officials through their organization, the National Conference on Weights and Measures, have begun planning for the effects of metric changeover on commercial weights and measures activities. Working with this group, for which the National Bureau of Standards maintains the Secretariat, NBS has already equipped each State with a set of metric standards and laboratory instruments that are NBS-certified as to accuracy.

On the Federal level, various metrication efforts have been underway to meet immediate needs. Since publication of the metric study in 1971, NBS has maintained a Metric Information Office. The volume of inquiries and requests have grown steadily. In one 6-month period in 1975, NBS answered 20,000 letters and 2,000 telephone calls for information. More than 100,000 NBS Metric Kits have been prepared and are being sold through the Government Printing Office. A national speakers bureau was formed to meet a need for metric information from civic, homemaker, PTA, and other groups.

The U.S. Metric Board assumes many of NBS' public information functions, but the Bureau will continue to provide international metric coordination through the General Conference on Weights and Measures created by the Treaty of the Meter. It is at this Conference that the components of the modernized metric system, International System of Units (SI), are agreed upon by the participating nations. The Bureau will also retain responsibility for maintaining the national measurement system, coordinating metrication with State weights and measures officials, and through its interaction with consumer, business, and scientific groups, assist the nation in the changeover to metric.

Activity in other Federal agencies is underway:

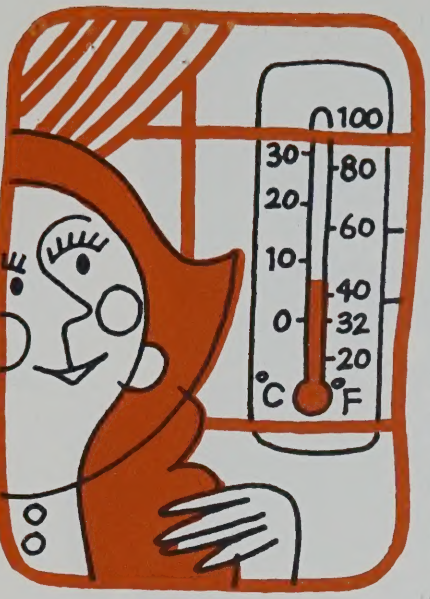
- The Department of Defense issued a policy statement in June 1975 that it would use metric when feasible, practical, and efficient.
- The Treasury Department, at the request of industry, has held hearings on new regulations that would specify metric-sized bottles for distilled alcoholic beverages. There was no opposition to these regulations at the hearings. Similar regulations have already been approved for the wine industry.
- The National Aeronautics and Space Administration has been using metric units extensively for several years.
- The Interagency Committee on Standards Policy, chaired by the Department of Commerce, has established a Metrication Subcommittee to help coordinate Federal agency metric activities.
- Other Federal agencies which have initiated some metric activity—ranging from forming committees to using metric publications and signs—include the Department of Interior, Federal Highway Administration, Federal Housing Administration, Department of Health, Education and Welfare, National Weather Service, Maritime Administration, Forest Service, National Park Service, Agriculture Department, Patent and Trademark Office, Environmental Protection Agency, and Federal Communications Commission.

Just why is the United States going metric after having lived with the English system for more than 200 years? The answer is quite simple: We cannot afford not to.

All of our major trading partners have either gone metric or are in the process of doing so. In fact, the only countries still not committed are Brunei, Burma, Liberia, and Yemen. Before the 1975 Act, we literally were an island in a metric sea. The British Commonwealth countries, with whom we shared the pounds-quarts-yards system for so long, have all committed themselves to metric. This includes Canada, our closest neighbor, which has an unofficial goal of being all-metric by 1980.

Our industrial community has also seen the necessity for metric conversion as markets for American goods and services expand overseas. In order to do effective business abroad, these large corporations have had to dual-dimension their products, create a separate production capability to turn out metric products for export, or abandon customary design altogether and produce all products in metric dimensions. More and more corporations are doing the latter.

We are also seeing some barriers being erected to U.S. products in customary dimensions. The Common Market in 1971 adopted a directive that requires all exporters to the nine Common Market nations to indicate the dimensions of their products in metric units by 1978. Dual dimensioning will be allowed only if determined not to be confusing, with each nation to judge compliance separately. This action could bar American goods from these markets or could lead to costly relabeling of products.



Ultimately, it is in our national best interest to convert to metric. And there is a decided advantage for American industries that "go metric." In addition to opening up new markets, the benefits of standardization under the metric system will be realized in reduced inventories. Manufacturers will not have to keep on hand as many product lines to correspond with various size requirements. For example, the Treasury Department's new regulations, scheduled to go into effect in 1979, will reduce the number of "standardized" wine bottles offered in this country from 16 to seven. The U.S. fastener industry will replace 59 customary sizes with 25 metric sizes for threaded fasteners.

A question frequently asked is what effect this changeover will have on the average citizen. Everyone will be affected, but the disruption in normal living will be minimal. Experience in other countries suggests that the American public will have little trouble in mastering the few metric units it will need for everyday living.

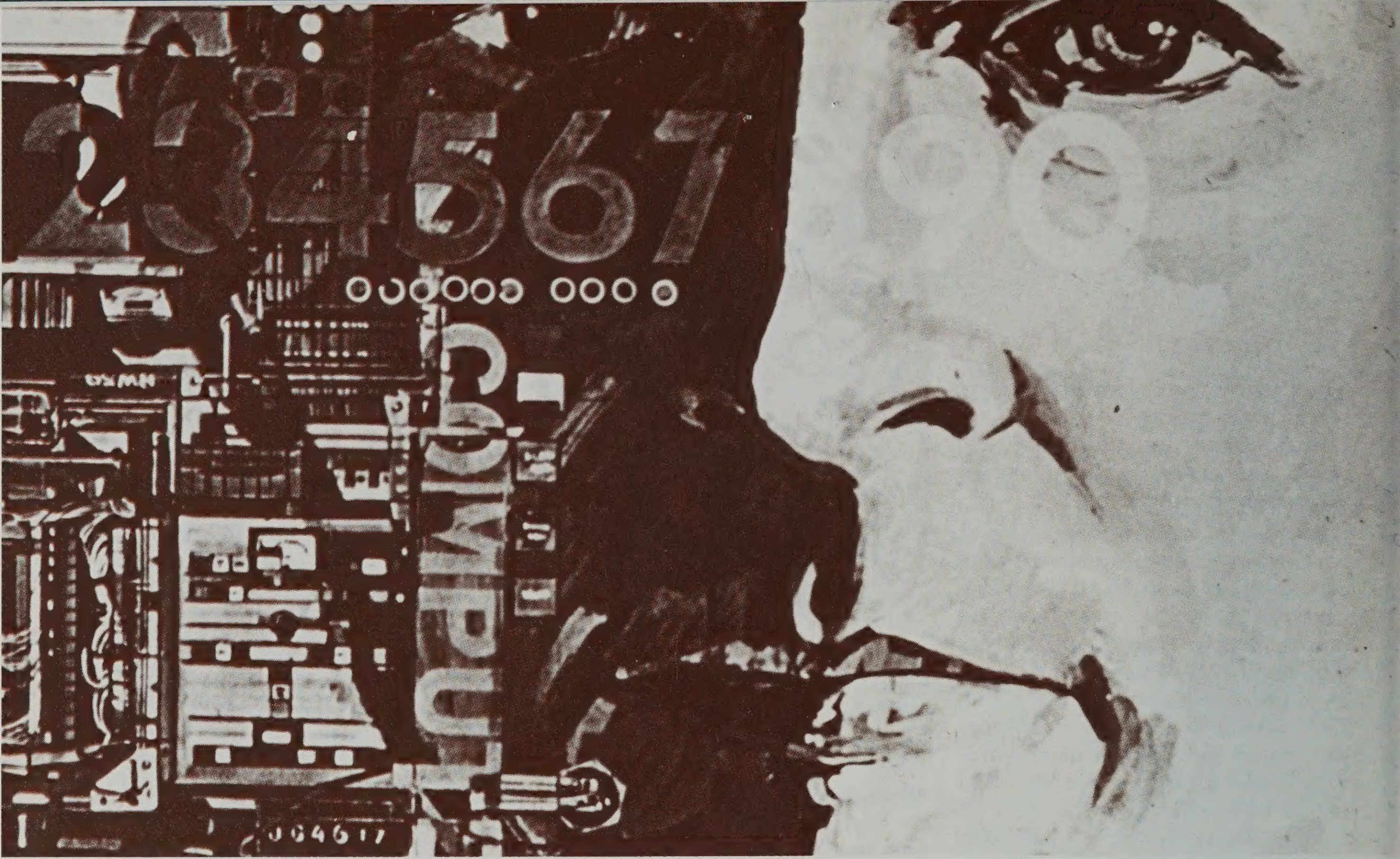
Most persons will need to know only three measurement units—meters, liters and grams. A meter is a unit of length slightly longer than a yard; a liter is a measure of volume and is a little larger than a quart; a gram is a unit of weight about as heavy as a paper clip. Because gram is such a small unit, it is easier to think about the kilogram (1000 grams), which amounts to a little more than 2 pounds.

Metric is a decimal system that uses multiples of 10, as does our currency system. Each basic metric unit can be multiplied or divided by factors of 10 to get larger and smaller units. These multiples and submultiples are indicated by prefixes such as kilo (one thousand), centi (one hundredth) and milli (one thousandth). Thus a kilometer means 1000 meters, a centimeter is 1/100 of a meter and a millimeter is 1/1000 of a meter.

Temperatures in metric are measured on the Celsius scale rather than Fahrenheit scale. (Celsius was formerly called Centigrade.) In the Celsius scale, water boils at 100 degrees and freezes at 0 degrees. This is easier to remember than in Fahrenheit, where water boils at 212 degrees and freezes at 32 degrees.

The changeover will create minimal confusion. Initially most items such as roadsigns and consumer goods will be labeled in both customary and metric dimensions. This is already happening with some automobile speedometers that are dually labeled. In the supermarket, canned goods will be labeled in both ounces and grams for a time (many are already) and eventually in grams alone.

The Metric Conversion Act of 1975 and the U.S. Metric Board which that Act creates will provide the necessary focal point for a smooth, coordinated conversion to the metric system in this country. No one will be forced to "go metric." But gradually, as each of our country's economic sectors see the desirability of going metric in a rational way, we will become a predominately metric nation. □



Computer Systems of the 1980's

*by Ruth M. Davis**

COMPUTER systems of the 1980's will primarily be serving two quite disparate sets of customers. The first type of customer can be characterized either as a large single organization using its computer system to manage and control diversified activities, or as an entire economic community which uses a computer system to link its various members together in the most efficient manner. Examples of these customers include multinational corporations, airlines, and the banking and law enforcement communities.

The second quite different set of customers is characterized by individual users wanting autonomous dedicated computer systems which can when needed be interconnected to larger computer service networks or other individual customers. Examples of these customers are individuals with minicomputers or intelligent terminals in their home or office, laboratory scientists occasionally needing greater calculation capabilities than they possess in their automated laboratory system and hospitals, universities, and retail stores.

The electronic technology and computer architecture advances occurring now are directed equally well at meeting the needs of both sets of customers. The salient features of the technology and architecture of the 1970's include advances in network design, data communications, distributed processing, modular processors, parallel processing, automated reading devices, and self-repairing circuitry. The 1980's will see networks containing computers and computer modules of all sizes, independent memories, and a large variety of access terminal and automated input devices.

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*Dr. Davis, Director of the NBS Institute for Computer Sciences and Technology, presented this material at the Diebold XXXV Conference, Amsterdam, The Netherlands, November 18, 1975.

Systems Reflect U.S. Policies

The computer systems of the 1980's will reflect the policies, objectives, and concerns of the United States, including increased productivity, government accountability to the public, national security, and privacy. One of the lessons learned in the later 1960's and early 1970's is that computer systems are pacing elements to many national policies and priorities. Consequently, much more attention should now be directed toward the computer science, technology, and architecture which will advance the computer power so much in demand.

The general expectation is that the 1980 computer systems (or fourth generation systems) will differ from their predecessors more in architecture than in technology. Semiconductor integrated circuits, magnetic core memories, and magnetic storage devices will continue to be the dominant components of computer equipment devices. Data communications will feature packet switching and a continuation of the on-going modification of voice communication systems to better match data transmission requirements. Intelligent and non-intelligent graphic and character display terminals will look much as they do today, changed only by incremental improvements in packaging and miniaturization.

Changes In Technology

Radical changes or dramatic innovations in computer technology will, of course, occur, taking place in most instances in research and development aimed at improved national security and space exploration. Products of such research and development will not find their way into civilian or commercial application until the 1990's or later.

However, a few important—even radical—changes in technology will result from demands, accompanied by research and development funding, by civilian or private sector special interest communities. Such technology changes will include automated reading technology, such as "wand" technology, and solid-state mass memory devices, such as "bubble memories," cross-tie memories, charged-coupled devices, read/write laser memories, and crystal memories.

Principal anticipated developments and uses of new automated data input technologies include Optical Character Recognition (OCR) wand readers and bar code readers, hand printed character readers, and voice recognition equipment. The principal commercial development efforts are in the point-of-sale areas, such as bar code readers for the grocery industry and its Universal Product Code, and wand readers for the retail industry.

Bar code readers now undergoing trial tests in supermarkets are under-the-counter laser beam scanners which free both hands of the checkout clerk who merely aligns the bar code on each item of merchandize and passes it near the window which is flush with the checkout counter. Identification and verification of a check digit causes the code to initiate a computer look-up of item description and price, which is displayed and printed for the customer.

Three-color bar code scanners of the wand type for reading special three-color bar codes for department stores are now also undergoing tests. Voice recognition has already become an accepted means for inputting data into automated systems. It has also been suggested that some of the techniques being developed by several organizations for personal identification employing signature verification may be applicable for data input.

In the area of memory technology, scientists currently strive for development of memories which feature low cost, high yield, and fast access to randomly located data. The trend of contemporary memory design is to optimize these features and to achieve the goal of reducing the memory element size to a molecular level.

In the 1980's, one can also expect to see software producers offering new software packages of all types. The national emphasis on increased productivity can be conjectured to impact on computer software through renewed demands for program emulators that will allow fourth generation computer systems to run application programs developed for earlier generation systems. This will be the near-term technique for meeting higher productivity levels.

Performance measurement will be a standard practice employed by computer systems managers. Shared computer services, principally offered by computer service vendors through

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MERCURY THERMOMET

[Photo courtesy of Clinical Center, National Institutes of Health.]

In hospitals, clinics, and doctors' offices, electronic thermometers built around temperature sensitive resistors are replacing the familiar mercury thermometer.

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ARE THEY BECOMING ANTIQUES?

*by Dr. B.W. Mangum**

MEASURING temperature, if only by placing a hand against a fevered brow, has always been of interest to the medical profession. But with increasing sophistication and delicacy in clinical testing, the old ways of measuring are not always good enough.

Old methods are, in fact, rapidly giving way to new techniques. Today, for instance, electronic devices using thermistors often replace the old standby, the mercury thermometer, even in the doctor's office. This new technique determines temperature by the voltage developed across the thermistor, whose electrical resistance changes rapidly with temperature. An even more recent advance in thermometry, developed last year by the National Bureau of Standards, determines temperature by measuring the rotation of a beam of polarized light.

The need for increasing precision in temperature measurement came with the development of new and more complex biological tests, especially in clinical chemistry and hematology—the study of blood. Such tests measure, for example, the rates of enzyme reactions in the blood to detect the presence of disease or to check whether the patient has recently suffered a heart attack.

Approximately 50 percent of the clinical tests in these fields are sufficiently temperature-sensitive to cause concern about its measurement and control. Some 25 percent of the tests are performed by enzyme rate analysis using automated enzyme analysers—tests so sensitive that a 0.1 °C change in temperature results in a 1 percent error from temperature alone.

NBS Program

When the National Bureau of Standards Medical Thermometry Program was started in 1973, the best practical thermometer available to the clinical laboratory had an uncertainty of 0.3 °C against the International Practical Temperature Scale (IPTS) of 1968. (The IPTS-68 is an internationally agreed upon Practical Temperature Scale that is based on defining fixed points and which has designated procedures for interpolating between those points. The Scale has been chosen in such a way that the temperature measured on it closely approximates the thermodynamic temperature). In order to correct that situation, thermometers specially designed for clinical laboratory use were produced, calibrated, and made available to the public through the Office of Standard Reference Materials.

These thermometers, known as Standard Reference Materials (SRM) 933 and 934, have an error no greater than 0.03 °C.

Since then the Medical Thermometry Program has sought both to improve the thermometers available for clinical use and to improve the standards by which these thermometers are calibrated and tested.

Nearly four billion clinical tests will be conducted this year, with about one-half of them being temperature sensitive. Well aware that the traditional thermometers are neither fast enough, accurate enough, or small enough to be of use, many clinical instrument manufacturers in recent years have turned to electronic thermometers—employing thermistors and, to a lesser extent, platinum resistors—that offer smaller size, rapid response, high sensitivity, and a low price.

Thermistors are, technically, ceramic semiconductors. Generally made of manganese and nickel oxides, they are extremely temperature sensitive. As temperature rises, the electrical resistance of the thermistor decreases. The resistance varies exponentially with temperature. (Very simply, this means that a small change in temperature causes a much greater change in electrical resistance.) One commercially available model is guaranteed to vary no more than 5 millikelvins (0.005 °C) per year, but others are less reliable.

The platinum RTD (Resistance Temperature Detector) also involves electrical resistance, but the temperature dependence works the other

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*Dr. B.W. Mangum is a solid state physicist in the Heat Division of the National Bureau of Standards Institute for Basic Standards.

way. As temperature increases, the resistance of the platinum thermometer increases. The change is not exponential, however, so the platinum RTD is much less sensitive than a thermistor. Accuracy is usually about 0.1 °C.

Although use of these electronic thermometers is now widespread, users generally know very little about their stability over long periods of time, or their behavior on thermal cycling—heating the sensor to an elevated temperature, 100 °C to 300 °C, say, and then cooling it down to a lower temperature.

In addition, the temperature sensors in some clinical instruments, such as the automatic enzyme analyzers, are sealed in the machine by the manufacturer and so are inaccessible to the user. Clinicians concerned about whether the sensors transmit true values of the temperature are unable to check the calibrations or detect fluctuations of the sensors. Faulty thermistors in use in clinical machines have been known to drift as much as 8 °C from true values before being detected.

Thermistors Studied

To solve this problem, NBS has undertaken several study programs.

Bead and disc thermistors—two of the most common varieties, so named for their shape—are being studied, and the results to date indicate that either the medical instrument manufacturers or the thermistor manufacturers should monitor the thermistors for several months to check their stability before using them. Thermistors that initially have certain resistance values at a given temperature will sometimes vary widely from that value after prolonged use.

[Photo by Mark Helfer.]

A tympanic thermometer, holding a thermistor, measures body temperature at the middle ear membrane. They are particularly useful for obtaining a continuous reading of a patient's temperature on the operating table.

In addition, the researchers recommend that manufacturers make their thermistor sensors accessible for testing by the user, and that the user check the calibration of the sensors on a regular basis.

But these recommendations pose another problem. Are the clinical laboratories equipped to calibrate thermometers at the 0.05 °C to 0.1 °C level of uncertainty? These are the levels of uncertainty for temperature measurement specified in proposed standards for enzyme reactions by the International Federation of Clinical

Chemists and the American Association of Clinical Chemists, respectively.

To some extent, the thermometers SRM 933 and SRM 934 can serve laboratories as interim standards, but what is really needed is a series of temperature reference points in the range 0 °C to 100 °C and especially in the critical 0 °C to 60 °C range. If these points could be supplied, each clinical laboratory could have its own temperature standards section.

Temperature Reference Points

A temperature reference point is one at which a sharply defined change in a property of a substance, such as freezing, can serve as a temperature indicator. The NBS Medical Thermometry Group is presently working at supplying such reference points, studying several different techniques.

The long-standing practice of observing a phase change, such as melting or freezing, is probably the easiest and least expensive way of providing a reference point. Unfortunately, finding substances which are easy to obtain in a pure, consistent and reliable form, with sharply defined phase changes in the critical range, is difficult.

The ice point of water, 0 °C, is a reliable reference point. In addition, gallium, a metal which can be obtained in a very pure form, has a melting point near 30 °C, and the preliminary results of tests by NBS researchers indicate that the phase change is sufficiently reproducible to be suitable for use in clinical laboratories as a reference point.

Other techniques for providing temperature reference points are more subtle, such as the use of nuclear quadrupole resonance (NQR). This method depends on the fact that certain types of nuclei have what are known as "quadrupole moments" because of their non-spherical shape. The interaction between the quadrupole moment and the electric field gradient produced by surrounding ions splits the nuclei's energy levels. When an outside source of electromagnetic radiation, impinging on the nuclei, reaches a certain frequency which corresponds to the energy splitting of the nuclei, a resonance is set up. This frequency, the "resonance frequency," depends on the temperature of the material and provides a very sensitive and accurate thermometer.

Nuclear quadrupole resonance thermometry is not new and a considerable amount of work has been done at NBS and elsewhere on the NQR of two chlorine isotopes, ^{35}Cl and ^{37}Cl, in potassium chlorate ($KClO_3$), a material familiar because of its use in match tips and weedkillers.

Usually, the NQR frequency is used as a thermometer. As temperature changes, the frequency of the radiation source is changed by a sensing device to maintain resonance, and the temperature is gauged by the frequency. At NBS, however, the Medical Thermometry Group plans to fix the frequency so that resonance will occur at a predetermined temperature, the reference point. Each frequency selected then provides a new reference point that can be used to calibrate clinical thermometers.

Another technique for providing temperature reference points is to observe the so-called "magnetic transitions" of suitable materials. There are four distinct classes of magnetic phenomena in substances: diamagnetism, paramagnetism, ferromagnetism, and antiferromagnetism.

The important fact for medical thermometry is that some substances will shift from one magnetic state to another at a specific temperature which is sharply enough defined to be used as a reference point.

One such possibility being studied is the paramagnetic-to-antiferromagnetic transition of chromium, which takes place near 38 °C. This point, known as the Néel temperature, marks a sharp maximum in the specific heat of chromium and may be a means of detecting that temperature. This effect is still being investigated.

Radiation Treatment

Apart from the stability of electronic thermometers, and the need for fixed reference points, another critical area in medical thermometry is in measuring temperature distribution in tissue while it is being treated with intense electromagnetic (EM) radiation. This problem is encountered in the production of hyperthermia, an exceptionally high-temperature condition used in cancer therapy, and in bioeffects research and diathermy, all cases where sensitive tissues are heated by electromagnetic waves.

The problem is particularly critical in hyperthermia treatment, where a variation of only a few tenths of a degree in the temperature of the irradiated tissue means the difference between killing the cancer and killing the healthy tissue.

Traditional thermometers are worse than useless in this case. Being either metallic or semiconductors, they are themselves heated by currents induced by the electromagnetic field. The temperature in the thermometer

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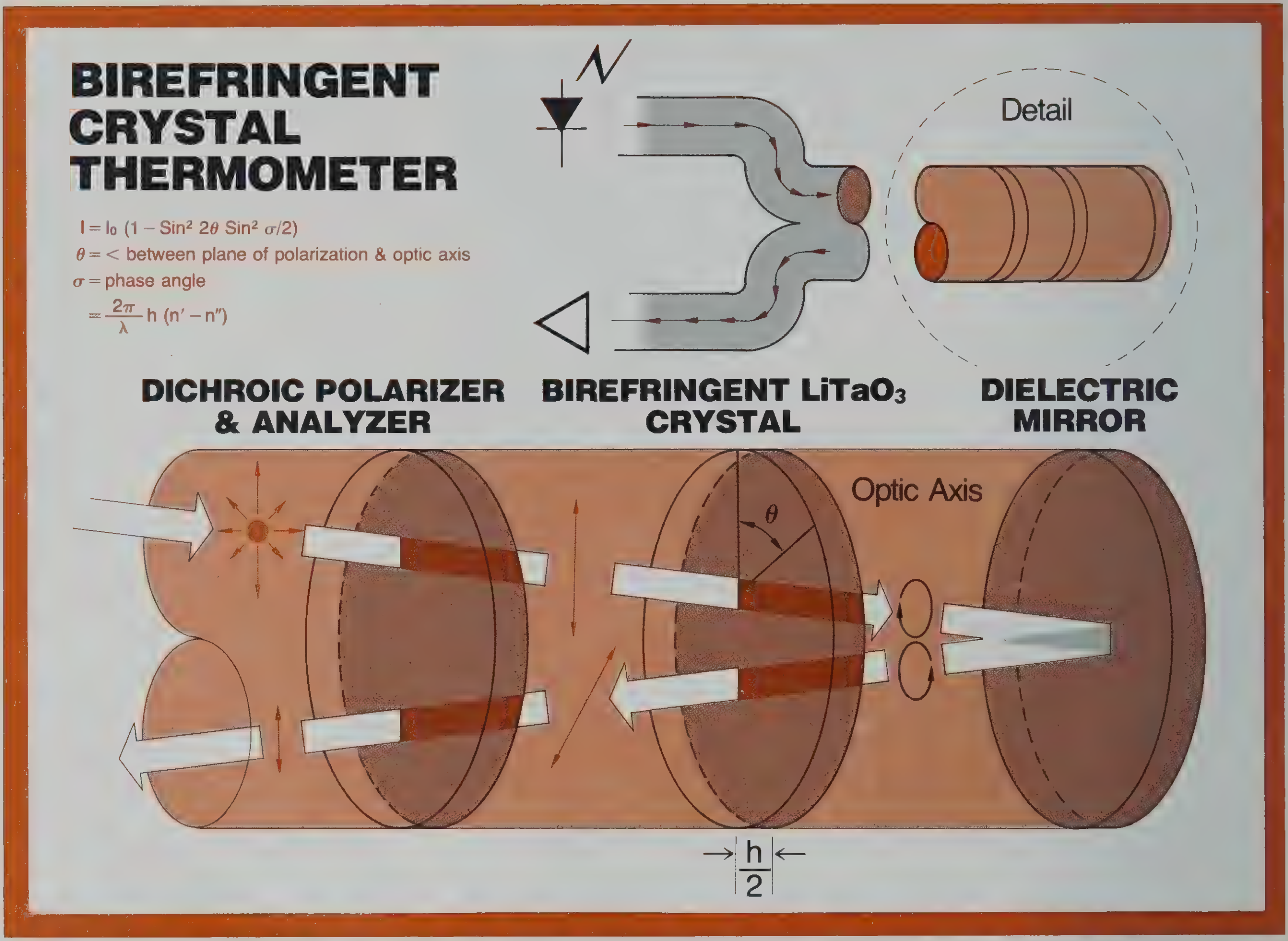
BIREFRINGENT CRYSTAL THERMOMETER
$I = I_0 (1 - \sin^2 2\theta \sin^2 \sigma/2)$
$\theta = <$ between plane of polarization & optic axis
$\sigma =$ phase angle
$= \frac{2\pi}{\lambda} h (n' - n'')$
Detail
DICHROIC POLARIZER & ANALYZER
BIREFRINGENT $LiTaO_3$ CRYSTAL
DIELECTRIC MIRROR
Optic Axis
θ
$\frac{h}{2}$

LATEST DEVELOPMENT IN THERMOMETRY

The sensor probe consists of a dichroic polarizer and analyzer, a thin single crystal of lithium tantalate, and a dielectric mirror (see diagram).

Light from a source, usually a light emitting diode, is brought into the sensor by a bundle of optical fibers about 0.5 mm in diameter. The light is polarized in one plane by the polarizer, passes through the lithium tantalate crystal and is circularly polarized, reflects from the mirror back through the crystal and analyzer and then through a second bundle of optical fibers to a sensitive photodetector.

As the light passes each way through the lithium tantalate crystal, it is rotated away from its original plane of polarization by an amount that depends on the temperature of the probe. This reduces the amount of light that passes through the analyzer. The amount of light received by the photodetector at the end of the probe corresponds to the temperature of the probe. The greater the angle of refraction, the less light received.

rises several degrees above that of the surrounding medium, throwing off the accuracy and at the same time creating localized "hot spots" by distorting the EM field.

Temperature By Light

The search for a non-electrically conducting material that has some physical property sufficiently temperature sensitive to make a good thermometer eventually led NBS scientists to lithium tantalate ($LiTaO_3$). Lithium tantalate is "optically active." It forms a birefringent crystal, and the birefringence is temperature sensitive.

Birefrigence, or double refraction, is a property of some crystals, the most familiar being calcite, or Iceland spar, wherein light going through the crystal is split into two different planes of polarization, perpendicular to each other. (To understand polarization, think of the effect of polarizing sunglasses. The light beams entering the eye "flow" in one direction along a plane once they pass through the polarizing lens. As a result, the glare from light entering the eye from many angles (planes) is eliminated). The angle at which the light is bent, or refracted, depends on how it is polarized. Look at a candle flame through a birefringent crystal and you see two images, one vertically polarized, the other horizontally polarized. In a lithium tantalate crystal, the angle of refraction also depends, quite sensitively, on the temperature of the crystal.

Using lithium tantalate, NBS has developed a miniature temperature probe, called a birefringent crystal thermometer, that shows no induced heating in an EM field and is highly sensitive.

[Photo by H. Glittenberg.]

This disc thermistor, though small, is big compared to some bead thermistors, which may be no larger than a speck of dust.

Using a 0.1 mm thick crystal, a thermometer can be built with a temperature range of 35 °C that is accurate to 0.05 °C. This temperature probe circumvents all of the measurement problems encountered by other thermometers, and in addition can be used in situations where electric shock hazards are critical.

New and improved temperature scales and instruments are of no use, however, until they get into the hospitals and laboratories where they are needed. With this in mind, NBS has carried out measurement assurance programs with some selected high quality groups. During these programs, NBS staff members interact with clinical groups to help assure that measurement systems are producing acceptable measurements. In addition, NBS has developed an accurate small, and practical temperature measurement system, consisting of a calibrated thermistor, a constant current source, a standard resistor and a digital voltmeter, which has been undergoing field trials in selected laboratories.

By working with selected laboratories, with voluntary standards organizations (such as the American Association of Clinical Chemists and the College of American Pathologists), and with the regulatory agencies, NBS hopes to make a substantial impact in the improvement of thermometry throughout the medical field. This improvement should then be reflected in an improvement in the Nation's health care. ☐

HIGHLIGHTS

Corrosion and Metal Artifacts Conference

NBS will host and co-sponsor a conference on "Corrosion and Metal Artifacts" March 14-19, 1976. This meeting is another in a continuing series of "Corrosion Weeks" that have been held for a number of years under sponsorship of Centre Belge d'Etude de la Corrosion (CEBELCOR) and other institutions. The meeting seeks to bring together museum conservators and scientists, archaeologists, and engineers to consider the effective use of corrosion science and technology in the areas of conservation and archaeology. Other sponsors include the Smithsonian Institution, American University, and the Washington Conservation Guild. Contact Dr. Jerome Kruger, Chief, Corrosion and Electrodeposition Section, Materials Building, Room B254, NBS, Washington, D.C. 20234 or call (301) 921-2094.

New Voluntary Product Standard for Paints

NBS has approved a new standard entitled, "Paints and Inks for Art Education in Schools" for publication as a Department of Commerce Voluntary Product Standard. The standard, PS 65-75, establishes nationally recognized requirements for preservatives, toxicity, coarse particle content, performance, working qualities, and packaging for school paints and inks. Single copies of PS 65-75 may be obtained from the Standards Development Services Section, NBS, Washington, D.C. 20234.

NBS-NRL Study Neutron Scattering

A new collaborative neutron scattering program has been initiated by NBS and the Naval Research Laboratory. The program will initially emphasize the study, by elastic and inelastic neutron scattering, of magnetic materials including some of the current technologically important rare-earth based compounds. Initial impetus for the program has been a study of magnetic excitations in $ErFe_2$, one of a class of materials which show promise for sonar transducers.

Weights and Measures to New Jersey

On December 11, New Jersey became the 46th State to receive new standards under an NBS program to replace the weights and measures standards in all 50 States, the District of Columbia, Puerto Rico and the Virgin Islands. Included in the 95-piece set of instruments are standards both in the U.S. customary system and the metric system. The program was initiated at the request of the National Conference on Weights and Measures because many of the standards and instruments formerly used by the States in weights and measures administration were provided by the Federal Government 100 years ago or more.

1975 Automotive Paint Colors

NBS has prepared a reference collection of 1975 automotive paints. It is a sequel to the reference collection of 1974 automotive paint colors and comprises those colors first introduced on 1975 U.S.-model cars.

The collection is being issued by the NBS Office of Standard Reference Materials as RM-75, and is available at $33 per set. For further information, write Robert Mills of the Law Enforcement Standards Laboratory (LESL), NBS, Washington, D.C. 20234 or call (301) 921-3161.

Economic Decisions and MIUS

An NBS report, "Economic Objectives of Utility Companies and Developers in Evaluating a MIUS" (NBSIR 75-721), by Brit Jeffrey Bartter is now available. This report provides information to the Department of Housing and Urban Development's Modular Integrated Utility System (HUD-MIUS) program about the economic decision-making process for implementation of MIUS by utility companies, developers, or a combination of these two groups. Anyone interested in the program or the report can contact: Joel Levy, Building 226, Room A319, NBS, Washington, D.C. 20234 or call (301) 921-3701.

Solar Heating Equipment Standards

NBS is developing Intermediate Standards that the Department of Housing and Urban Development's Federal Housing Administration can use to determine the acceptability of solar heating equipment for mortgage insurance. In support of HUD's activities authorized by the "Solar Heating and Cooling Demonstration Act of 1974," NBS is developing a technical performance data requirements plan. This plan has two objectives: (1) to ensure that adequate technical data are obtained from the demonstration program to permit the technical evaluation of the solar-powered equipment demonstrated and (2) to develop performance standards for solar-powered equipment. □

Evaluating Economic Performance of Solar Energy Systems

GUIDELINES for evaluating the economic costs and benefits of solar heating and cooling systems for buildings have been developed by an economist at the National Bureau of Standards.

The guidelines are expected to provide researchers and analysts with reliable and consistent procedures for comparing the economic merits of solar energy systems with conventional heating and cooling systems. This information is needed since the widespread use of solar energy systems in buildings hinges in large part on their relative economic performance.

Economist Rosalie T. Ruegg in the NBS' Center for Building Technology shows step-by-step how life-cycle cost methods may be applied to the evaluation of solar heating and cooling systems in a technical report, "Solar Heating and Cooling in Buildings: Methods of Economic Evaluation."

The report identifies the relevant kinds of costs over the lifetime of the heating and cooling system and describes how the effective costs to the owner of a solar-equipped residence or commercial building would be altered by income taxes, insurance, and governmental incentives programs.

In the first section of the report, Ruegg develops generalized life-cycle cost and benefit-cost models, explains the techniques for developing models for unique systems, and discusses the sensitivity of costs to key assumptions, such as discount rates, period of analysis, fuel costs, and construction and labor costs.

A case example illustrates a benefit-cost comparison of a solar heating system and a conventional system.

While the report is intended primarily as a resource document for research analysts, it provides the background for the type of comparison that is needed by builders, architects, lenders, manufacturers of solar energy equipment, government policy makers, homeowners, and others for decision making situations in which a solar system is being considered over a conventional system.

A second part of the report explains the economic conditions for making cost-effective tradeoffs in the design of a heating and cooling system within a building. This section of the report discusses the problem of designing a "least-cost" system that will satisfy requirements of comfort, heat delivery, and energy conservation under a given situation.

The 41-page report may be ordered from the National Technical Information Service (NTIS) for $3.75 in hardcopy or $2.25 in microfiche. The identification number which must be used to order the report from NTIS is COM-75-11070. ☐

Papers Solicited for Major Environmental Conference

PAPERS are now being solicited for a major conference on the state-of-the-art and future of air and water pollution measurement to be held next year at the National Bureau of Standards.

The 8th Materials Research Symposium: Methods and Standards for Environmental Measurement will be held on September 20-24, 1976, at the NBS facilities in Gaithersburg, Md.

The symposium will consist of a series of invited lectures by environmental experts as well as the presentation of contributed papers. Both lectures and contributed papers will focus on topics which are in the early stages of development or which are the subject of discussion or controversy regarding their applicability to environmental measurement problems.

Examples of these topics from which a selection will be made in organizing the symposium are as follows:

- Application of laser technology to atmospheric monitoring.
- Determination of trace organic pollutants in water.
- Multielement analysis.

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Papers *continued*

- Accuracy requirements in air and water pollution measurement.
- Achieving accuracy in air and water pollution measurement.
- Legal and economical consequences of measurement inaccuracy.
- The need for and problems associated with *in-situ*, real time monitoring.
- Speciation—needs and problems.
- The role of voluntary standards organizations in air and water pollution measurement.
- Physical and chemical characterization of aerosols.
- Laboratory certification and licensing in the field of air and water pollution.
- Significance of collaborative testing.
- The function of reference materials.

Persons interested in submitting papers should send abstracts of 250 to 350 words prior to March 1, 1976, to Dr. James R. McNesby, Chief, Office of Air and Water Measurement (OAWM), NBS, Room A345, Chemistry Building, Washington, D.C. 20234. For additional information on attending the conference write OAWM or call (301) 921-3775.

Because of time limitations, some manuscripts may be accepted for inclusion in the written proceedings which are not presented orally at the symposium. Proceedings of the symposium will be prepared consisting of extended abstracts (1000-2000 words) of all papers and plenary talks.

The symposium is sponsored by the NBS Institute for Materials Research which sponsored the first Materials Symposium in 1966. The 7th Materials Research Symposium on trace analysis was held October 7-11, 1974. It attracted nearly 450 scientists from 18 countries, 36 States, and the District of Columbia. ☐

Lead Nitrate SRM Now Available

STANDARD Reference Material (SRM) 928, Lead Nitrate, is now available from the National Bureau of Standards Office of Standard Reference Materials.

SRM 928 is intended for use in the calibration and standardization of procedures employed in clinical and toxicological analysis, as well as in routine evaluation of daily working standards used in such procedures. The new SRM is also useful in quality control by manufacturers of clinical chemicals, working standards, and kits.

The development by NBS, in cooperation with a number of clinical laboratories, of a reference method for lead, provided additional impetus for issuing this SRM.

Lead is one of the most serious and ubiquitous of the metallic poisons. Both inorganic and organic lead compounds are used extensively in industry. Lead paint is an especially serious problem in the case of children in older housing areas. Diagnosis of lead poisoning is difficult and the demonstration of an elevated lead level in blood or urine constitutes positive indication of the absorption of a lead compound.

In order to achieve valid results, analytical methods for lead must be extremely sensitive, accurate, and carefully conducted. SRM 928, and the complementary reference method for lead in blood that is now under development, will improve the validity and usefulness of diagnostic lead data.

The lead nitrate was assayed at $100.0_1 \pm 0.0_1$ percent by chemical analysis. Spectrochemical analysis showed essentially no measurable metallic impurities. Humidity-drying cycle experiments showed this SRM to be unaffected by atmospheric conditions.

SRM 928 can be ordered from the Office of Standard Reference Materials, Room B311, Chemistry Building, NBS, Washington, D.C. 20234, at a price of $43 for 30 grams. ☐

Lag Time for Nuclear Power Plant Standards

THE Nuclear Regulatory Commission (NRC) and the Experimental Technology Incentives Program (ETIP) of the National Bureau of Standards have been experimenting with ways to accelerate the development of nuclear standards which may be used in the licensing and operation of nuclear power plants. In three experiments just concluded it appears that the time required to develop a draft standard was reduced from several years to a few months.

Regulatory Guides are used by

[Photo courtesy Argonne National Laboratory.]

NRC to provide acceptable, but not mandatory, methods of complying with regulations which have the force of law. In addition, guides tell industry what to expect in a licensing review and indicate specific information that should be included in applications. More than 190 standards are now referenced in NRC regulations and guides.

"ETIP is interested in discovering ways to reduce unnecessary delays in the regulatory process," said Dr. Jordan Lewis, ETIP's director. "Those delays end up costing everyone more —business and consumers." This ETIP project addresses the need of the NRC for the efficient and expeditious development of standards which may be used in the regulatory process.

The project was jointly developed by NRC and ETIP. ETIP supplied approximately $100,000 for the project, and NRC provided the management expertise. NRC selected the Nuclear Standards Management Board of the American National Standards Institute (ANSI) to manage the experiment. ANSI, in turn, chose Battelle's Pacific Northwest Laboratories to provide the necessary technical and engineering support.

Specifically, ETIP and NRC engaged in a series of experiments to accelerate the development of three draft nuclear standards. These are the certification of nuclear materials managers, the discharge of thermal effluents into surface waters, and guidelines for combining natural phenomena and manmade hazards at nuclear power reactor sites.

The objective of this project was to determine if any or all of the following four changes in the method of developing nuclear standards accelerated the development of the standards.

First, working groups of nuclear experts were assembled for periods up to 2 weeks to work full time on developing each standard. Where necessary, members of these panels were paid for their time, or their firms were reimbursed for the time involved. This insured that ETIP and NRC received full attention of these knowledgeable individuals.

Secondly, full time chairmen were provided. Thus the working groups were managed by an experienced chairman concentrating on producing the required standard.

Third, the chairman and working groups were provided with consultant services for collection and correlation of basic data that are required by the group developing the standard.

The fourth change introduced into the standards development procedure was the use of clerical and technical editing in order to accelerate the process of preparing initial and revised drafts of standards and supporting documents.

NRC is currently in the process of awarding a contract for the formal evaluation of the project. The plan for the evaluation was, like the project itself, jointly developed by NRC and ETIP and will be funded by ETIP.

ETIP was begun in fiscal 1973 as a means of stimulating private and government investment in research and development. By the end of fiscal 1975, ETIP had committed $10 million to cooperative projects with other government agencies and to policy studies. □

Fire Symposium Scheduled as 75th Anniversary Event

A 2-day symposium on fire standards and safety will be held at the National Bureau of Standards, Gaithersburg, Md., on April 5 and 6, 1976.

The symposium will be a major event planned by the Institute for Applied Technology (IAT) in celebration of NBS' 75th anniversary.

IAT's fire research program contributes to the goal set by the National Commission on Fire Prevention and Control which has called for a reduction of 50 percent in the Nation's fire losses in a generation.

Although the United States is the world's most technologically advanced country, it is also the world

turn page

Simple calibration system for police radars developed by NBS

Fire *continued*

leader in fire losses. More than 12,000 Americans are killed in fires every year and 250,000 are severely burned.

Property loss to fire is valued at over $3 billion yearly. Fire fighting is one of the Nation's most hazardous occupations in terms of death and injuries.

The first day of the NBS symposium will be devoted to characterizing the fire hazard in the United States and will include such topics as fire loss experience, fire phenomena, and the role of tests in defining the fire hazard.

The second day will focus on efforts to reduce the risks of these fire hazards, such as the activities of regulatory agencies, fire research groups, and the National Fire Prevention and Control Administration (NFPCA). The symposium will conclude with brief comments by a panel of experts on fire problems and an open discussion of questions posed by attendees.

On April 7, the facilities of NBS' Institute for Applied Technology will be open to those attending the conference. These facilities include the Center for Fire Research, Center for Building Technology, Center for Consumer Product Technology, Electronic Technology Division, Office of Energy Programs, and Standards Application and Analysis Division.

Numerous events are planned for NBS' 75th Anniversary, which coincides with the Nation's 200th birthday. For more information on the Fire Symposium, contact the Center for Fire Research, Technology Building, Room B147, NBS, Washington, D.C. 20234, or call 301/921-3143. For general information concerning other events, contact Special Activities, Room A640, Administration Building, NBS, Washington, D.C. 20234. ☐

EVER since motorists first encountered radar traps along the streets and roads of America, they have wondered if the "speed-guns" really do measure speed more accurately than speedometers can.

Now the question can be settled to the satisfaction of courts, the police, and the public, because a simple, inexpensive way to calibrate the radar guns has been developed. The new calibration technique compares the tuning fork standards (used by police departments to calibrate the radar guns) with the Nation's standard of frequency, maintained by the National Bureau of Standards.

While simple and relatively inexpensive to purchase and operate, the new system provides traceability of calibration to NBS standards.

The system was developed by the Time and Frequency Division of NBS at Boulder, Colo. A pilot program has been successfully completed at the Colorado Weights and Measures Laboratory (CWML), and regular operations have begun at CWML to provide routine tuning fork calibrations for police departments all over the State.

NBS and CWML have offered to help any other interested States' standards labs to set up their own systems of calibration, and at least one commercial version of the calibration system has been marketed, with a price under $900.

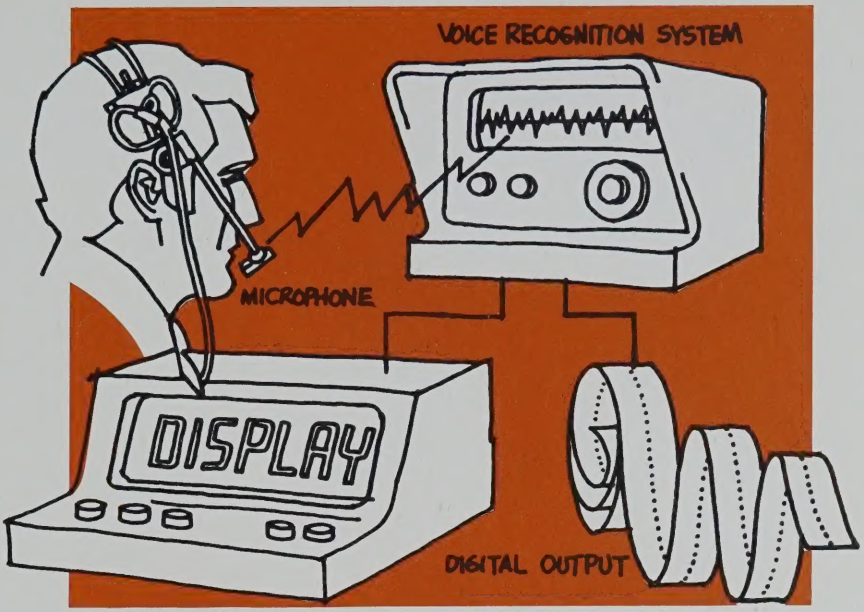
The new technique basically provides a means of comparing the tuning fork's frequency with the atomically-controlled frequencies from NBS radio station WWV. These WWV signals are available via telephone as well as over the air, and thus can be used anywhere in the U.S.

The Colorado experiment showed that the tuning forks are excellent local standards of frequency that do not change frequency significantly even when relatively severely abused. One fork even appeared to have been run over by a car, and still it vibrated at its specified frequency. If they are calibrated periodically against WWV, perhaps once every few months, those forks which occasionally do become defective can be eliminated from the radar calibration procedure.

In one jurisdiction, the State of Maryland, the radar guns have been systematically used since July 1975 in a campaign of rigorous speed-law enforcement. Local authorities across the Nation have been interested observers.

Maryland officials, in statistics released in September, reported arrests of more than 35,000 speeders in a 6-week period. The average number per day was more than double the number reported for the corresponding period of 1974. Nineteen fewer traffic fatalities were reported for the 6-week period as compared with the year before.

As officials strive to curb speeding in the interests of safety and reduced energy consumption, successful conclusion of the CWML/NBS pilot program provides evidence to courts, police and motorists of radar gun reliability and accuracy to within 1 mile per hour, the intended level of speed gun performance. ☐



computer networks, will be increasingly popular both in manufacturing and service areas. Small businesses will find it more cost-efficient and more productive to buy only that portion of a larger computer system's power when they need it, rather than making a large capital investment to meet demand.

The significantly increased use of computer systems in the 1980's for real-time control functions and for robotic-like automation will cause corollary increased demands for better input sensors, better real-time control packages, faster logic or greater parallel processing capability to handle real-time operations, and interconnection of functionally-related but geographically distinct real-time systems.

Management reliance on computerized models for planning, forecasting, and resource allocation will accelerate the development of mathematically reliable models and statistical program packages.

System Architecture

The generally developing consensus is that the architecture for computer systems of the 1980's will pull away from the monolithic, central processor-centered architecture of earlier computer generations:

It will closely mimic successful organizational structures and be functionally, equipmentally, and geographically diversified in what is commonly known as a distributed system.

As we move from the single-processor oriented computer system of the late 1960's to the distributed multiple processor interlinked architecture of the fourth generation systems, the importance of interfaces and protocols will be magnified. Specifically, interfaces and protocols need to be so specified and documented that users may substitute individual new technology devices in a system without having to replace interconnected hardware or without having to buy expensive new system software packages. Interfaces and protocols also enable users to prevent system vendors from inhibiting their choice of equipment and software by claiming exclusivity. They allow users to access "infinitely" large omission of "infinitely" powerful computer capabilities by successfully interconnecting their local computer systems to larger and larger computer networks or distributed systems, as need dictates. Interfaces and protocols also expedite the transnational flow of information between special interest communities while maintaining the security of the information.

We have predicted that the advantages of the computer systems of the 1980's are dependent upon users and not system vendors having control of interface and protocol specification and documentation. Historically, the only way of attaining such user control has been through standardization.

Presently, activities in interface standardization are being carried on in this country by the American National Standards Institute (ANSI) and by the National Bureau of Standards. The Bureau, in conjunction with the General Services Administration, has recently intensified efforts for developing both device-level and channel-level interface standards. The Federal government and the user communities in this country are emphasizing, with a real sense of urgency, the development and implementation of interface and protocol standards.

I have attempted to describe some of the characteristics of the computer systems of the 1980's. There are, however, certain capabilities or features essential to the acceptability of these envisioned systems which do not yet exist. These are epitomized by the present lack of information controls, privacy safeguards, audit procedures, performance measures for real-time control systems, interface standards, software validation, and documentation standards.

Assuming traditional technological ingenuity and innovativeness will meet the test, the future is bright for computer systems in the U.S. in the 1980's. □

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